

Acronyms, Glossary, and Authors

Acronym List

2D-GC Two-dimensional gas chromatography
3-D Three-dimensional

A

ACE American Coalition for Ethanol
AED Atomic emission detector
AFDC Alternative Fuels Distribution Center
API American Petroleum Institute
AQMD Air Quality Management District
AST Above-ground storage tank

B

BG Block group
BOD Biochemical oxygen demand
BPJ Best professional judgement
BRP Blue Ribbon Panel
BTEX Benzene, toluene, ethyl benzene, and xylene
BTX Benzene, toluene, and xylenes

C

CAA Clean Air Act
CalCVRWQCB California Central Valley Regional Water Quality Control Board
CAL-DHS California Department of Health Services
CAL-DWR California Department of Water Resources
CAL-EPA California Environmental Protection Agency
CARB California Air Resources Board
CAS Chemical Abstract Service
CBG Cleaner Burning Gasoline (Program)
CEC California Energy Commission
COC Contaminant of concern
COD Chemical oxygen demand
CRFA Canadian Renewable Fuels Association

D

DL Detection limits
DOE U.S. Department of Energy

F

FHC	Fuel hydrocarbon
FID	Flame ionization detectors
FP	Free product

G

GC	Gas chromatography
GC/FID	Gas chromatography with flame ionization detection
GC/MS	Gas chromatograph with a mass spectrometer
GEIMS	Geographic Environment Information Management System
GIS	Geographic Information System

H

HOC	Hydrophobic organic compound
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I

IFT	Interfacial tension
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L

LC ₅₀	Lethal concentration for 50% of a population
LLNL	Lawrence Livermore National Laboratory
LNAPL	Light nonaqueous phase liquid
LOD	limit of detection
LPA	Local primary agency
LUST	Leaking underground storage tank
LUSTIS	Leaking Underground Fuel Tank Information System

M

MC	Monte Carlo
MCI	Maximum contaminant level
MCL	maximum contaminant levels
MIR	Maximum Incremental Reactivity
MRI	Magnetic resonance imaging
MS	Mass spectrometer
MTBE	Methyl tertiary butyl ether

N

NAPL	Nonaqueous phase liquids
NDEQ	Nebraska Department of Environmental Quality
NESCAUM	Northeast States for Coordinated Air Use Management
NIST	National Institute of Science and Technology
NFP	Non-free product
NOM	Natural organic material

NRTL	Non-random-two-liquid (model)
NSTC	National Science and Technology Council
O	
OCWD	Orange County Water District
OEHHA	Office of Environmental Health Hazard Assessment
ONWR	Outstanding National Water Resource
P	
PAH	Polycyclic aromatic hydrocarbon
PCB	Polychlorinated biphenyl
PDF	Probability distribution function
PICME	Permitting, Inspections, Compliance, Monitoring, and Evaluation (database)
Q	
QA	Quality assurance
QC	Quality control
R	
RFA	Renewable Fuels Association
RFG	Reformulated gasoline
RVP	Reid vapor pressure
RWQCB	Regional Water Quality Control Board
S	
SB	Senate Bill
SCVWD	Santa Clara Valley Water District
SPCC	Spill prevention and containment contingency
SPME	Solid-phase microextraction
SRC	Syracuse Research Corporation
SWRCB	State Water Resources Control Board
T	
TCE	Tri-chloroethylene
TNC	Transient non-community
TPH	Total petroleum hydrocarbons
TRG	Tahoe Research Group
TRPA	Tahoe Regional Planning Agency
U	
UNIFAC	UNIQUAC functional-group activity coefficients
UNIQUAC	Universal quasi chemical
UNR	University of Nevada at Reno

US EPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
V	
VFA	Volatile fatty acid
VOA	Volatile organic analysis
VOC	Volatile organic chemicals (BTX, etc.)
W	
WQM	Water Quality Monitoring (database)

Ethanol Glossary

Accuracy	The agreement between the measured value and the accepted or “true” value.
Activation	The conversion of nontoxic chemicals to products harmful to humans, animals, plants, or microorganisms
Advection	The principal means of transporting hydrocarbons horizontally away from the gasoline-pool boundary with the flowing groundwater
Aerobic	Living or active in the presence of free oxygen; and aerobic process is one taking place in the presence of free oxygen. A state in which oxygen dissolved in water acts as an oxidizing agent.
Analyte	The specific component or element measured in a chemical analysis.
Anaerobic	Living or active in absence of oxygen. The remaining oxygen may be combined in the form of some organic or inorganic compound. Sulphate-reducing bacteria, though present in rivers, are normally inhibited by the presence of dissolved or free oxygen.
Biodegradation	The process of destruction or mineralization of either natural or synthetic materials by the microorganisms of soils, waters, or wastewater treatment systems.
Bioremediation	Use of indigenous microorganisms (or the catalysts that they produce) to degrade the target pollutants
Constitutive enzymes	Enzymes that are always produced (at some level) regardless of environmental conditions
Conventional gasoline	refers to gasoline used nationwide before 1995. Conventional gasoline typically does not contain any oxygenates, except in quantities of about 2 to 3% by volume, when refiners have chosen to add them as octane boosters. Conventional gasoline typically has higher benzene content than reformulated gasoline.
Desorption	The release of ions, molecules, or atoms from the surface of a solid.
Dispersion	The process whereby concentration of a dissolved chemical is reduced by dilution, and the contaminant front spreads faster than the average rate of ground water movement.
Detection limit	The minimal concentration of a substance which analytical techniques can detect with some degree of accuracy in various environmental samples, such as ground water. A detection level varies between substances, environmental conditions, samples, and laboratory equipment and technique.

Diffusion	The movement of suspended or dissolved particles from a more concentrated to a less concentrated region as a result of the random movement of individual particles; the process tends to distribute them uniformly throughout the available volume; a transport process.
Epilimnion	The relatively warm, upper layer of water in a body of water
False negative	An error where the incorrect decision is made that an analyte is not present (is not detected) when, in fact, it is present.
False positive	An error where the incorrect decision is made that an analyte is present (is detected) when, in fact, it is not present.
Flame Ionization Detector (FID)	A sensitive, general-purpose detector for most organic compounds.
Free convection	the process where bulk fluid flow occurs as a result of an unstable condition created when the fluid density increases vertically upwards. It occurs when a density gradient exists within a single fluid. If the gradient is such that the fluid is less dense near the bottom, a physically unstable fluid profile is created. As a result, a convective flow is established within the fluid, typically as “fingers,” thereby blending the high and low density portions of the fluid.
Gas chromatography	An analytical technique that employs separation of components of a gas phase mixture by passing the mixture through a column.
Gasohol	Gasoline containing alcohol, such as ethanol.
Groundwater	All subsurface water that occurs beneath the water table in rocks and geologic formations that are fully saturated.
Henry’s law constant	A mathematical description of the propensity for a compound to volatilize to air from water, or conversely, to enter water and remain in the water phase.
Hydrophobicity	Lacking an affinity for, repelling, or failing to adsorb or absorb water.
Hydrodynamic dispersion	The principal means for vertical transport away from the gasoline pool.
Hypolimnion	The colder, denser water layer at the bottom of a body of water.
<i>In situ</i>	In the original location.
Inducible enzymes	Enzymes that are produced only when an inducer (for example, toluene) is present at a higher concentration than the minimum threshold for induction
Intrinsic bioremediation	Natural conditions at contaminated sites meet all the essential environmental requirements so that bioremediation can occur at high rates without human interference
Isotherms	Mathematical relations between the concentration of a compound dissolved in water and its equilibrium concentration sorbed to a solid.

Mass-transfer velocity	The rate with which a compound moves from water to air as a function of its physicochemical properties and environmental conditions, such as water velocity of a stream, water temperature, and wind velocity.
Oxygenates	Organic molecules that contain oxygen. Oxygenates are typically alcohols (such as ethanol) or ethers (such as MTBE). The main purpose for adding oxygenates to fuels is to promote more efficient combustion under adverse conditions in the engine, such as cold starts or fuel-rich operations, when a substantial amount of fuel may escape the engine unburned. The extra oxygen in the fuel helps to convert carbon monoxide (CO, a product of incomplete combustion) to carbon dioxide. To a lesser extent, the extra fuel-bound oxygen may help to convert hydrocarbons, also formed as products of incomplete combustion, to carbon dioxide and water.
Oxyfuels	Oxygenated fuels that contain oxygenates at concentrations on the order of 10 to 15% by volume.
pH	Water with pH values between 0 and 7 is acidic; with pH value of 7 is neutral; with pH values between 7 and 14 is alkaline.
Plume	A visible or measurable discharge of a contaminant from a given point of origin. A plume can be visible or thermal in water.
Precision	A measure of data reproducibility. It is assessed by replicate measurements of reference materials, samples, or method performance samples
Reformulated gasoline (RFG)	<p>RFG differs from conventional gasoline with respect to several fuel parameters.</p> <p>RFG is intended to reduce automotive pollutant formation, especially evaporative emissions and exhaust emissions of photochemical ozone precursors. The most important targeted ozone precursors are volatile organic compounds (VOCs). RFG is also intended to reduce air toxic emissions, specified in the Clean Air Act Amendments as benzene, 1,3-butadiene, formaldehyde, and acetaldehyde. Compared to conventional gasoline, RFG has reduced vapor pressure (to lower evaporative emissions), reduced sulfur content (to prevent poisoning of catalytic converters), and reduced aromatic and benzene content (to decrease evaporative and exhaust emissions of these compounds). Reformulated fuel may or may not include oxygenated compounds; the term “reformulated gasoline” does NOT itself imply the presence of oxygenates.</p>
Sorption	Temporary retention of the contaminant on soil and sediment particles
Substrates	In biochemistry, the substance with which an enzyme reacts.

Surface water	Natural water bodies, such as rivers, streams, brooks, and lakes, as well as artificial water courses, such as irrigation industrial and navigational canals, in direct contact with the atmosphere.
Volatile fatty acids	Produced by anaerobic metabolism of ethanol
Volatilization	The loss of a substance to the air from a surface or from solution by evaporation.
Xenophores	Organic compounds (Cl, NO ₂ , CN, and SO ₃) that make the molecule difficult to be recognized by these pathways

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Authors

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have a combined experience of over 30 years of research and monitoring at Lake Tahoe. They have been active in MTBE research in surface waters since 1996 and published the first comprehensive scientific journal article on the sources and fate and transport of MTBE in Donner Lake, CA. They played key roles in the University of California's document, "Health & Environmental Assessment of MTBE," which was requested by the California Legislature (Senate Bill 521) and presented to the Governor in 1998. Each author has given numerous talks to state and national groups on this topic and are currently working with colleagues in the University of California at Davis Department of Civil & Environmental Engineering to develop a set of guidelines for recreational activities in surface drinking water supplies based on marine engine emissions and lake hydrodynamic modeling.

Pedro J. Alvarez

holds a B.Eng. degree in civil engineering from McGill University, and M.S. and Ph.D. degrees in environmental engineering from the University of Michigan. He is an Associate Professor of civil and environmental engineering at the University of Iowa, where he also serves as Associate Director for the Center for Biocatalysis and Bioprocessing.

His research interests are related to the implications and applications of biological treatment processes to remove hazardous substances from contaminated water, wastewater, and soil. Current projects include catabolic enzyme expression under various substrate and electron-acceptor conditions; degradation kinetics; fate and transport of toxic chemicals in aquifer systems; reductive treatment and biogeochemical interactions with zero-valent iron; and phytoremediation. His teaching interests include biological treatment processes, environmental microbiology, and biotic and abiotic transformations of xenobiotic compounds.

Dr. Alvarez is a P.E. (registered in Michigan and Iowa), a certified groundwater professional, and a Diplomate of the American Academy of Environmental Engineers with Diplomate

status (DEE). His honors include the Collegiate Excellence in Teaching Award from the University of Iowa (1998); the Alejo Zuloaga Medal from the Universidad de Carabobo, Venezuela (1996); a Career Award from the National Science Foundation (1995); the Best Paper Award from the EPA/HSRC for Regions 7 and 8 (1995); and the Outstanding Achievement Award in Environmental Engineering from the University of Michigan (1991).

Jeffrey I. Daniels is the Risk Sciences Group Leader in the Health & Ecological Assessment Division of the Earth & Environmental Sciences Directorate at Lawrence Livermore National Laboratory (LLNL). He received his doctorate in environmental science and engineering (D.Env.) from the University of California at Los Angeles in 1981. He also holds a B.S. in biology and a M.S. in microbiology. Dr. Daniels recently served on two National Academy of Sciences and Institute of Medicine committees that addressed medical response to chemical and biological terrorism and reviewed risk assessment methodologies for determining reference doses to chemical warfare agents.

Dr. Daniels is the co-author of a report for the U.S. Department of Energy that assesses the potential human health risks from groundwater contaminated by radioactivity introduced at the Nevada Test Site, and a journal article describing a bases for secondary standards for residual radionuclides in soil. He has been invited by the Swedish Government to attend and present at international meetings focusing on the use of multimedia, multipathway exposure assessment and risk analysis as a prognostic and diagnostic tool for selecting strategies to deal with hazardous waste. In 1995, Dr. Daniels served as a consultant to the Harvard Institute for International Development. In that capacity he was an instructor at the Risk Assessment Workshop held at the Gorbachev Institute in Moscow, Russia, that was organized and sponsored by the U.S. State Department for scientists from the Newly Independent States (former Soviet Union). His general interests include risk analysis, multimedia-multipathway exposure assessment, and microbiology. Dr. Daniels is a member of the Health Physics Society (HPS), Sigma Xi, and the American Association for the Advancement of Science (AAAS), and is a Past President of the Northern California Chapter of the Society for Risk Analysis (NCCSRA).

Brendan P. Dooher is a systems analyst and risk assessor with Lawrence Livermore National Laboratory (LLNL). He received his Ph.D. in mechanical engineering in 1998 from the University of California at Los Angeles, where he studied probabilistic risk assessment and environmental systems under the direction of Professor Bill Kastenberg and Daniel M. Tellep, Distinguished Professor of Engineering.

Dr. Dooher has worked extensively with California public agencies to assess the threat to public water supplies and resources from leaking underground fuel tank sites and methyl tertiary butyl ether (MTBE). He has helped create the interactive Geographic Information System site, GeoTracker, to help regulators, responsible parties, and the public to assess the vulnerability of water supplies more cost effectively and to develop a “living groundwater model” for California.

Stephen E. Heermann holds a M.S. in hydrology from the New Mexico School of Mining and Technology and a B.S. in geology from the University of Maryland. He is a doctoral candidate in the environmental engineering program at Clarkson University in New York state. For his dissertation, Mr. Heermann is studying the potential for ethanol in gasoline to enhance the groundwater transport of aromatic gasoline compounds following an accidental release of gasohol into the subsurface. He is investigating a number of physiochemical processes governing the fate and transport of ethanol and gasoline compounds in the subsurface, including cosolvency effects, the mass transfer of ethanol and gasoline compounds between gasoline and ground water, and the transport of ethanol and gasoline compounds via ground water.

Mr. Heermann previously worked as a hydrogeologist for S.S. Papadopoulos and Associates and Bechtel Corporation.

Craig S. Hunt is a post-doctoral researcher with the Civil and Environmental Engineering Department of the University of Iowa. He received a Ph.D. in environmental engineering in 1999 from the University of Iowa. He studied the effects of supplementary substrates on the biodegradation of monoaromatic hydrocarbons under the guidance of Associate Professor Pedro J. Alvarez. He has co-authored two papers in this area. Currently, Dr. Hunt is investigating the effect of ethanol on the bioremediation of underground gasoline contamination with the use of aquifer column and chemostat studies.

Carolyn J. Koester, Ph.D., is a research chemist with Lawrence Livermore National Laboratory (LLNL). She received a doctorate in analytical chemistry in 1991 from Indiana University, where she studied the atmospheric fate and deposition of chlorinated dioxins and furans under the direction of Distinguished Professor Ronald A. Hites. During a postdoctoral appointment with Trent University and Ontario Ministry of Environment and Energy, she studied environmental applications of liquid chromatography/mass spectrometry and ion trap mass spectrometers.

Dr. Koester's current interests include the study of extraction and mass spectrometric techniques for the determination of trace concentrations of polar organic compounds, including methyl tertiary butyl ether (MTBE), perchlorate, and various pesticides, in water. She has co-authored 13 papers in the area of environmental chemistry, including four recent "Environmental Analysis" review articles for *Analytical Chemistry*.

David Layton is the Division Leader of the Health and Ecological Assessment Division at Lawrence Livermore National Laboratory (LLNL).

During the early part of his 24-year career, his research focused on the health and environmental impacts of geothermal energy development in the western United States. Later, he led a major assessment of the information available on conventional ordnance (i.e., explosives and propellants) in order to support studies of the impacts of weapons demilitarization. He was also one of the lead investigators of a U.S. Department of Defense-funded project to revise the field-water quality standards used by the U.S. military.

After these projects, his research emphasis gradually shifted to the development of quantitative risk assessments of environmental contaminants. He has prepared risk assessments of hazardous gas releases, residual groundwater contamination at a Superfund site, plutonium-contaminated soils, heterocyclic amines in cooked foods, and nuclear wastes dumped in the Arctic Ocean. In addition, he has worked to improve exposure parameters for use in risk assessments. For example, he developed a metabolically-based method for determining breathing rates and conducted research on the resuspension of particles indoors. More recently, he has initiated projects dealing with the assessment of additives for transportation fuels.

Walt W. McNab, Jr., Ph.D., is an environmental scientist with Lawrence Livermore National Laboratory (LLNL). He received his doctorate in hydrogeology in 1995 from the University of California at Berkeley, where he studied reactive transport modeling through groundwater systems under T.N. Narasimhan.

Dr. McNab has worked on projects involving the analyses of multi-site groundwater contamination data. These have included serving on an expert panel convened by the U.S. Department of Defense, Petroleum Hydrocarbon Cleanup Demonstration Program. This project assessed the role of bioattenuation in limiting the risks posed by subsurface fuel releases at California military. Dr. McNab has also been the data analysis task leader for U.S. Department of Energy/LLNL's chlorinated hydrocarbon historical case analysis initiative. He has authored a number of papers on issues related to groundwater contamination, including articles in *Environmental Monitoring and Assessment*, *Ground Water*, and *Water Resources Research*, which discussed modeling and statistical approaches for understanding fuel hydrocarbon bioattenuation signatures in aquifers.

Alfredo A. Marchetti is a research chemist with Lawrence Livermore National Laboratory (LLNL). He received a License in Analytical Chemistry from the University of Buenos Aires, Argentina, in 1984, and a Ph.D. in nuclear chemistry in 1991 from the University of Maryland.

Since 1992, he has worked in LLNL's Health and Ecological Assessment Division. He is the LLNL principal investigator in a collaborative project addressing the Hiroshima neutron dose discrepancy. He has been a key contributor to the Chernobyl radiiodine dose reconstruction project. He has devised methods of iodine analysis in biological and soil samples using gas chromatography. He has developed the target chemistry for the determination by accelerator mass spectrometry of nickel-63, technetium-99, iodine-129, and chlorine-36 in a variety of environmental matrices. He is co-author in 17 peer-reviewed publications and is a member of the American Chemical Society.

Susan E. Powers is an Associate Professor in the Department of Civil and Environmental Engineering at Clarkson University in upstate New York. She received her Ph.D. in environmental engineering from the University of Michigan in 1992, where she studied the dissolution of nonaqueous phase liquids (NAPLs) entrapped within porous media under the guidance of Drs. Walter Weber and Linda Abriola. She received a B.S. and a M.S. in chemical engineering and environmental engineering, respectively, from Clarkson University.

Dr. Powers's current research focuses on understanding the physical and chemical phenomena associated with multiphase flow and contaminant transport in subsurface systems, with specific emphasis on the fate, transport, and remediation of NAPLs in complex systems. Her current research projects include the complexities associated with aquifer heterogeneities and nonideal chemical mixtures, such as coal tars and oxygenated gasoline.

David W. Rice is the Environmental Chemistry and Biology Group Leader for the Environmental Protection Department at Lawrence Livermore National Laboratory (LLNL). He is an expert in the fate and transport of contaminants in subsurface sediments, groundwater, and the marine environment. Mr. Rice has a B.A. in biology and a Life Secondary Education Credential from San Jose State University, and a M.A. in marine biology through the California State University Moss Landing Marine Science Institute.

During his 23 years at LLNL, Mr. Rice has participated in the management of the LLNL Superfund sites and directed and performed research on environmental decision-making, information management, and the application of natural process to environmental remediation. Mr. Rice has acted as Project Director for Chlorinated VOC Historical Case Analysis Initiative, Department of Defense Petroleum Hydrocarbon Cleanup Demonstration Program, and the Revision of California Leaking Underground Fuel Tank Cleanup Process. He is presently the Project Director for evaluating the potential surface and ground water impacts that may result from the use of ethanol as a replacement for MTBE in gasoline.

Mr. Rice has authored or co-authored over 50 publications. He is a member of the World Federation of Scientists Monitoring Panel on Water and Pollution and the Scientific Advisory Board for the Association for the Environmental Health of Soils. He is a recipient of the Lawrence Livermore National Laboratory Director's Performance Award.